

**MINIMIZATION OF ATMOSPHERIC
EMISSIONS IN THE HYDROCARBON
PROCESSING INDUSTRY
WITH
HIGH EFFICIENCY PLATE-AND-SHELL
HEAT EXCHANGERS**

Texas Technology Showcase 2003

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Atmospheric Emissions from Use of Energy in the HPI

- **Fired Heaters are Typically the Largest Consumers of Energy and the Largest Contributors to Atmospheric Emissions by Oil Refineries.**
- **Example of Utility Consumption at a Particular Diesel HDS Unit**

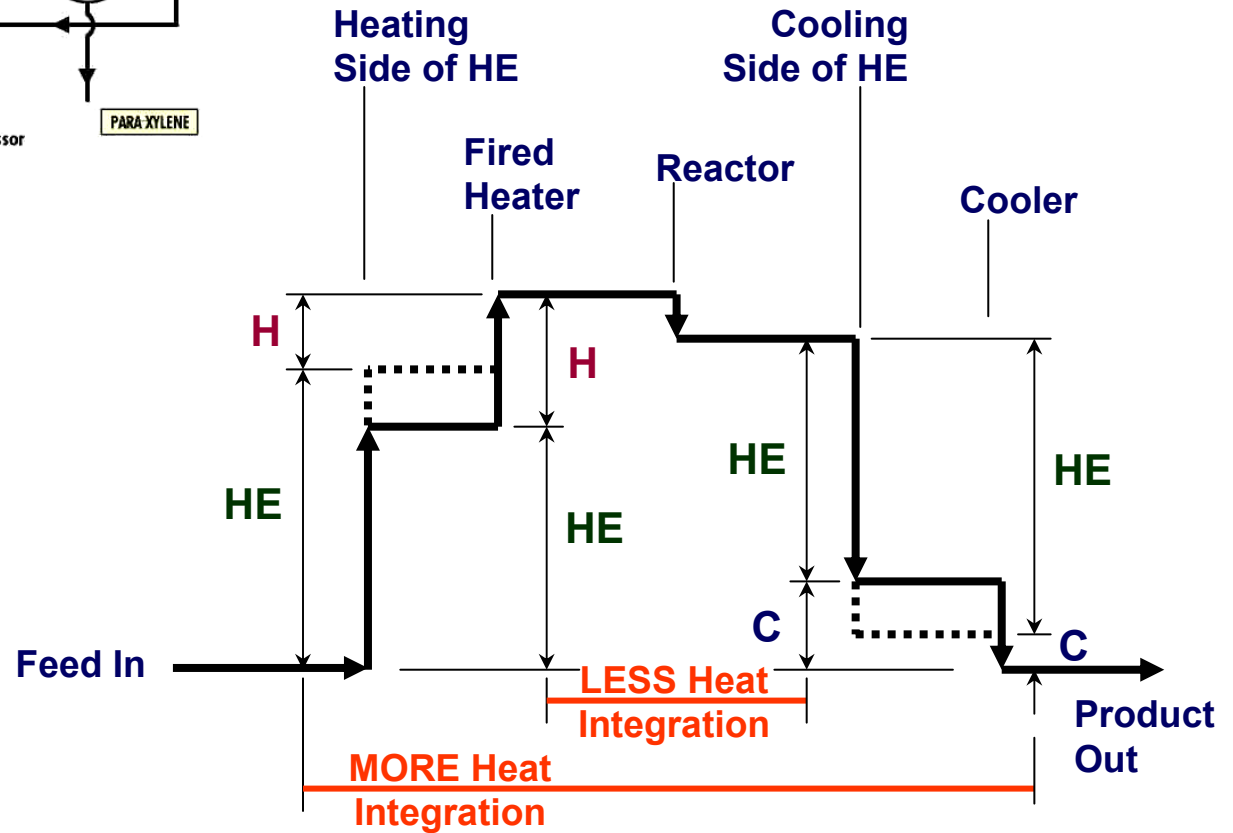
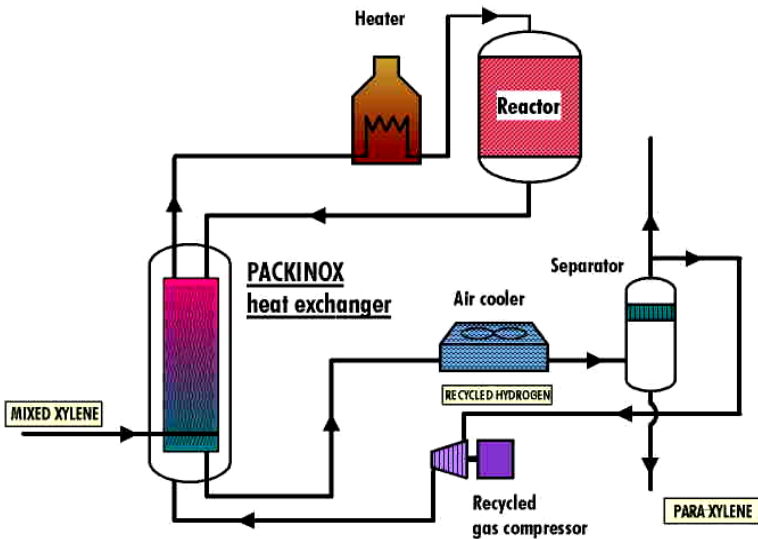
— Fired Heater	19 ¢ / bbl	6 lb. GHG / bbl
— Compressor	6 ¢ / bbl	(*)
— Product Cooler	1 ¢ / bbl	(*)
- **Energy Consumption is Usually the Second or Third Largest Cost Center of a Refinery**
 - First = Crude Oil Supply
 - Next is either Personnel or Energy

Atmospheric Emissions from Use of Energy in the HPI

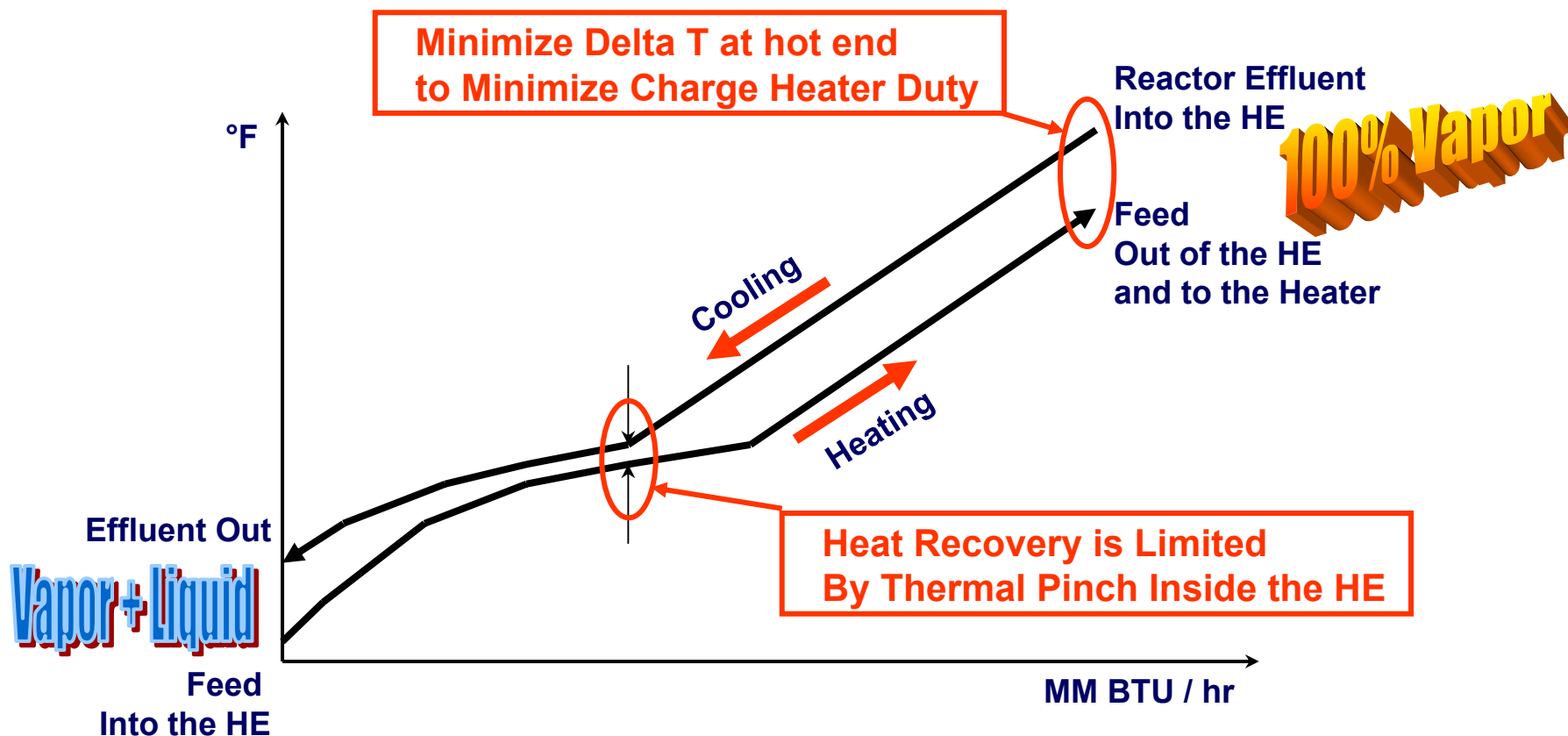
Conclusion:

- Minimizing the Use of Fired Heaters is both:
 - Good for the Refinery's Bottom Line Economics
 - An Excellent Method to Reduce Atmospheric Emissions.
- This Paper Suggests a Method and a Tool to **REDUCE THE NEED FOR MANY FIRED HEATERS IN A REFINERY**

Heat Integration



Thermal Pinch Inside the HE



PSHE as Best Equipment to Achieve Minimum Pinch

Barriers to Reducing the Pinch:

- **The LMTD Diminishes Rapidly with the Pinch, and the Required Heat Transfer Surface Area Increases just as Fast**
- **The Tube Length Equivalent Increases Rapidly**
- **Complete Vaporization of the Feed is Needed**

PSHE as Best Equipment to Achieve Minimum Pinch

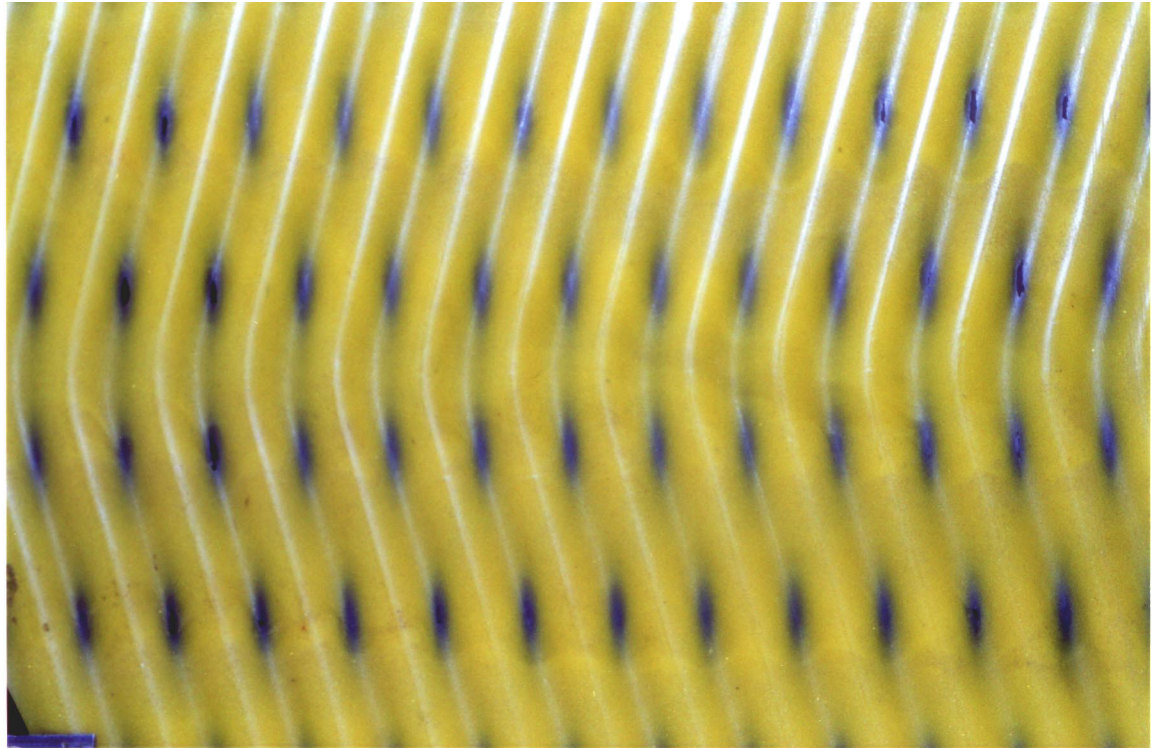
**Heat Transfer
Through Very Large
Corrugated Plates:**

- **Huge Surface Area in a Compact Design**
- **Very Long Tube Length Equivalent**
- **Corrugations Give High Turbulence to Help Complete Vaporization**



PSHE as Best Equipment to Achieve Minimum Pinch

- **Corrugated Surface Works as a Static Mixer**
- **Maintains high Turbulence and Promotes Two-phase Flow Distribution**
- **Allows Easy Superheating**



PSHE as Best Equipment to Achieve Minimum Pinch

- Liquid Feed Injectors Allow Very Good Control of Liquid - Vapor Feed Distribution
- Allows Better Heat Transfer Inside the Plate Bundle

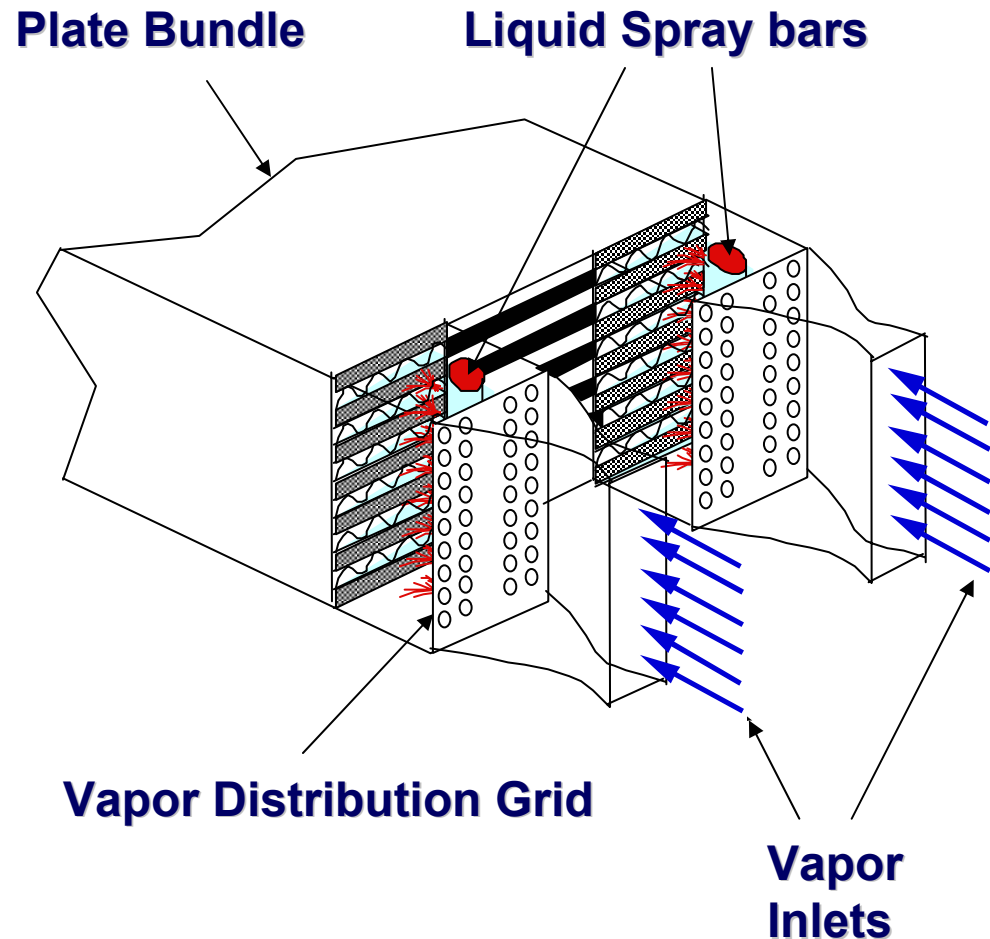
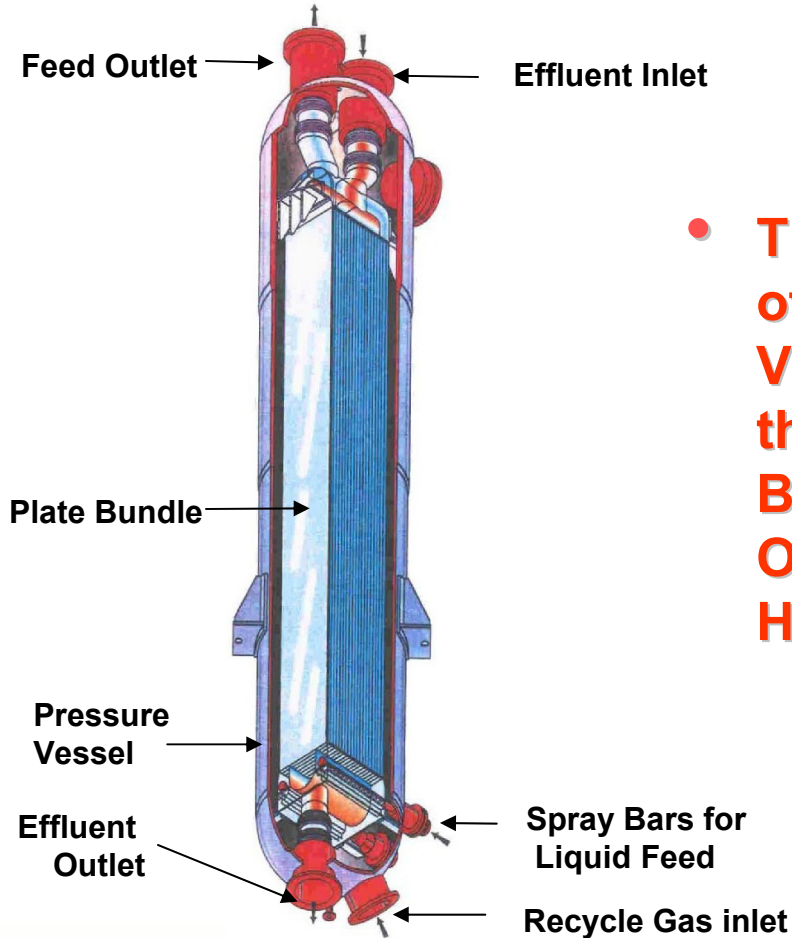


Plate-and-Shell HE as Best Equipment to Achieve Minimum Pinch



- The Protection of a Pressure Vessel Allows the Plate Bundle to Operate at High T and P



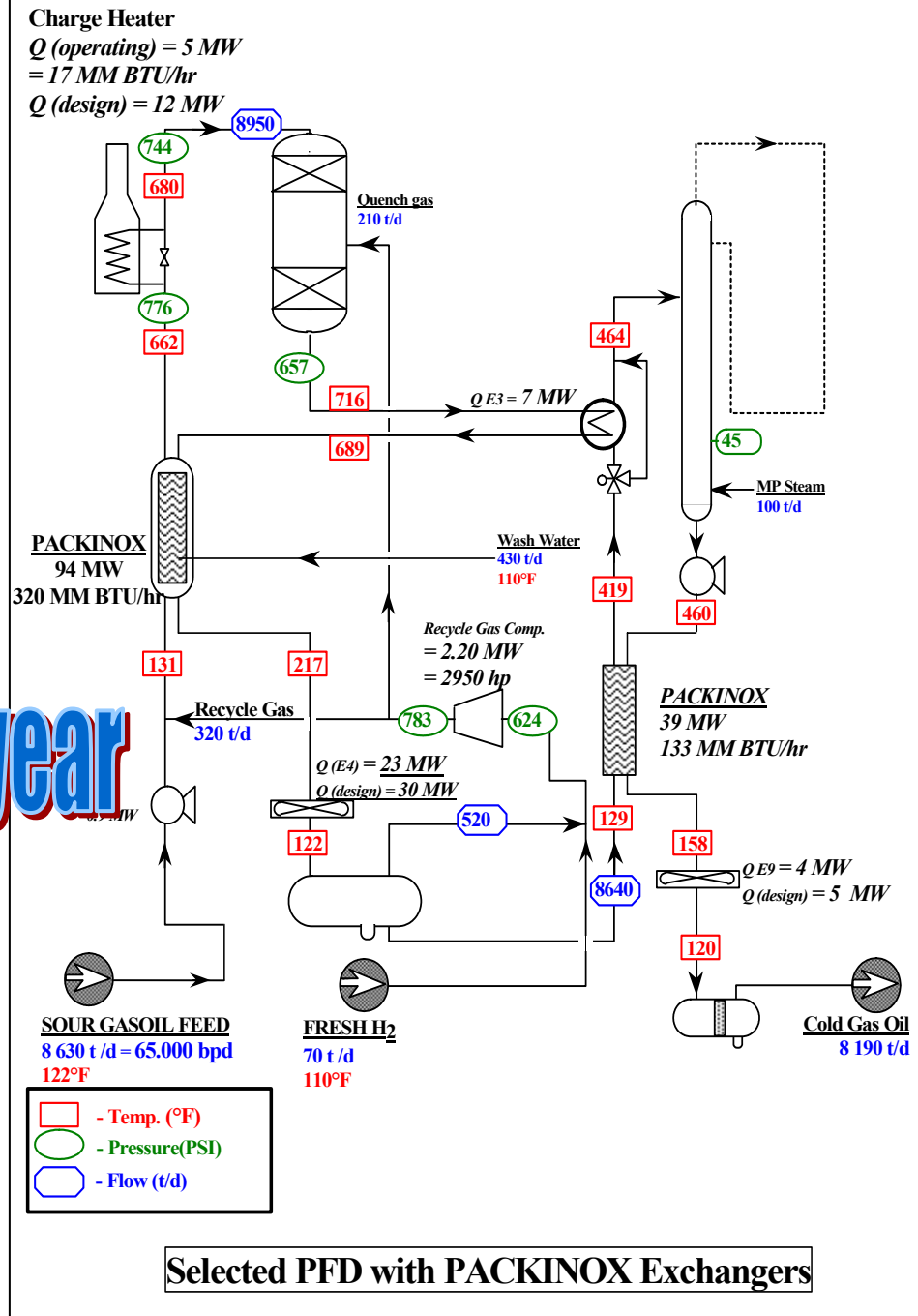
Case Story: Diesel Hydrotreater

Two 65.000 bpd Units at
Formosa Petrochemical

- **Eliminated:**
 - 75% of Heater Duty
 - 40% of Compressor HP
 - 40% of Cooler Duty

50.000 tons CO₂ Equiv / year

- On line Since 12/2000
- Savings per Unit:
 - CAPEX > \$5 Million
 - OPEX > \$3 Million / yr

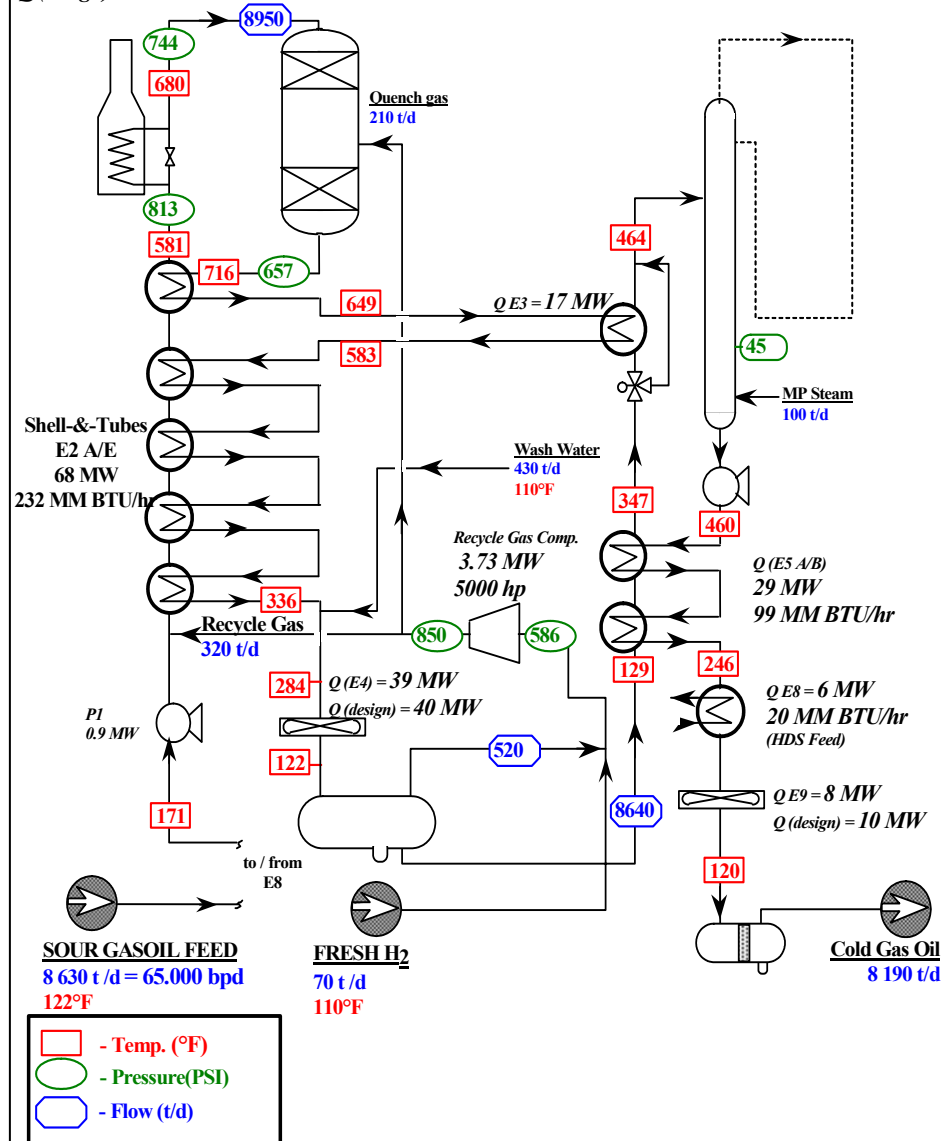


Case Story: Diesel Hydrotreater

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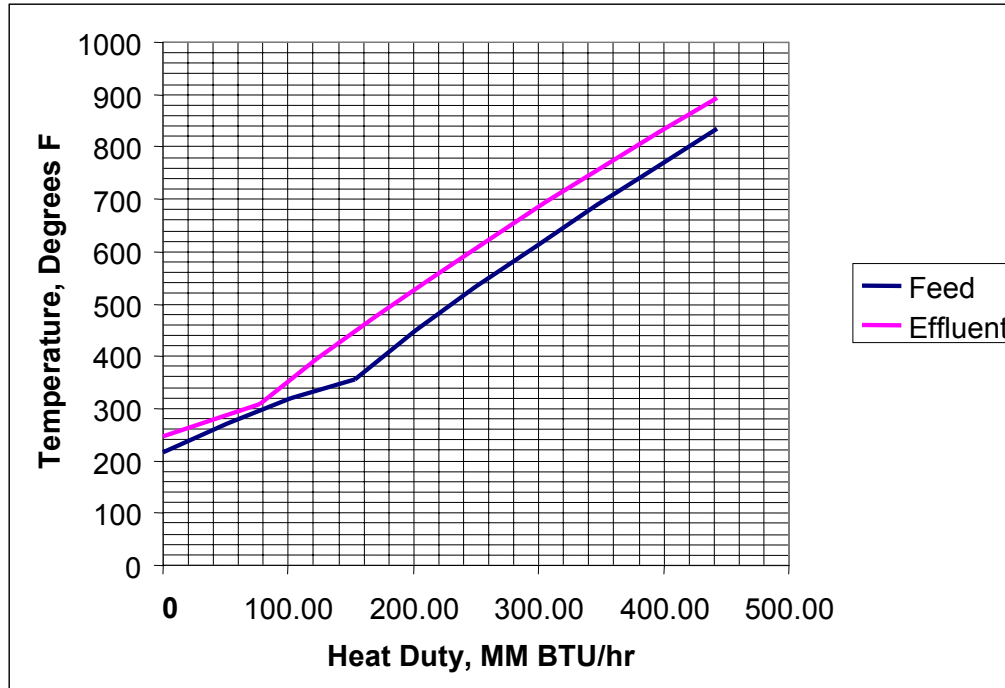
- Same Unit based on S&T:
 - Heater: 78 MM BTU/hr
v. 17 MM BTU/hr
 - Compressor: 5000 hp v.
2950 hp
 - Cooler: 133 MM BTU/hr
v. 78 MM BTU/hr

Charge Heater
 Q (operating) = 23 MW
 = 78 MM BTU/hr
 Q (design) = 25 MW



Planned PFD with Shell-&-Tube Exchangers

Case Story: Catalytic Reforming

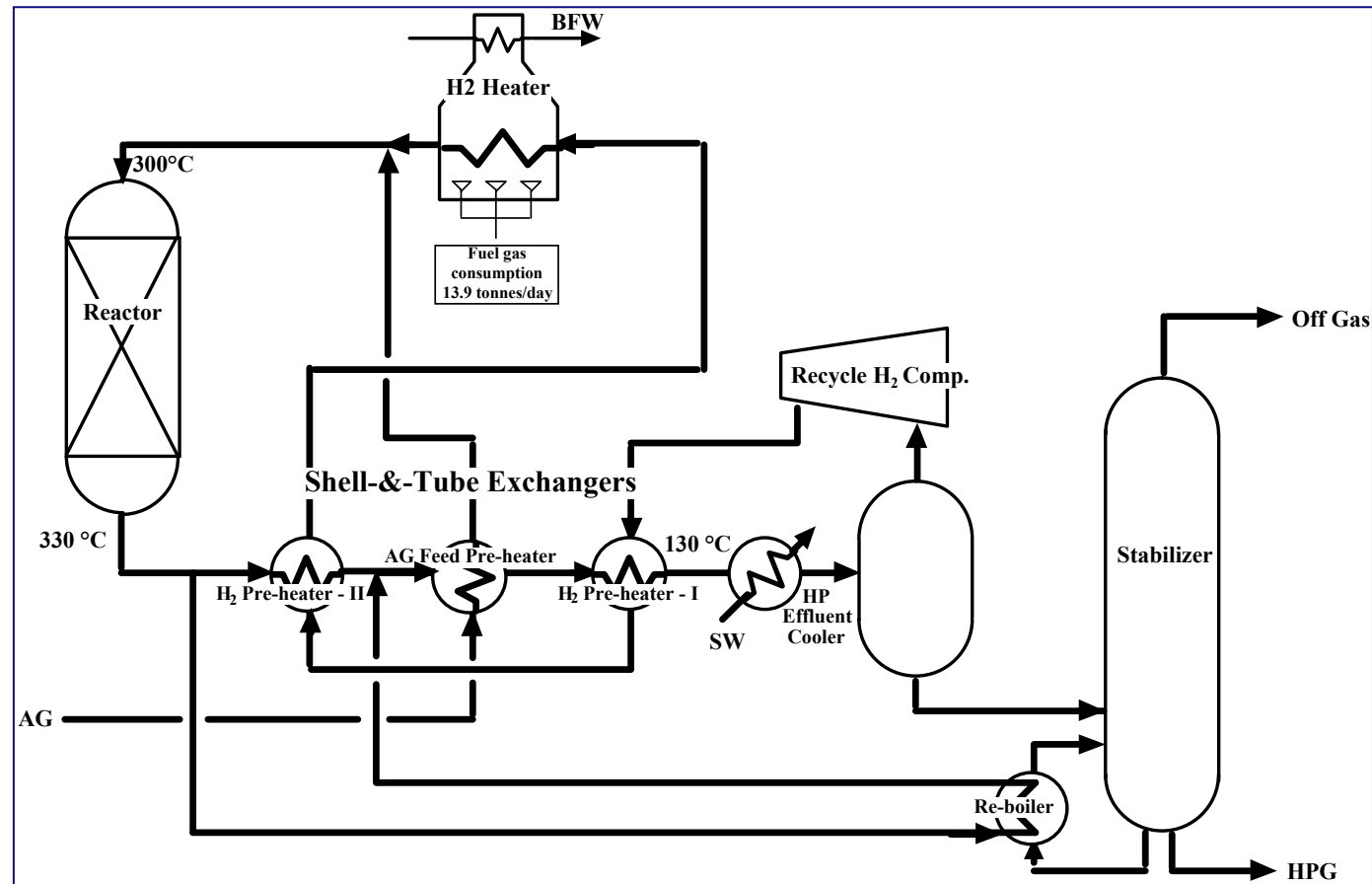


**More than 50 Units
Retrofitted Around the
World**

- **Two Reduction Samples in North America:**
 - **59.000 tons CO2 Equiv. / yr on a 40.000 bpd Reformer**
 - **16.500 tons / yr on a 26.000 bpd Reformer**

Case Story: Pygas Hydrotreater (Mitsui, Japan)

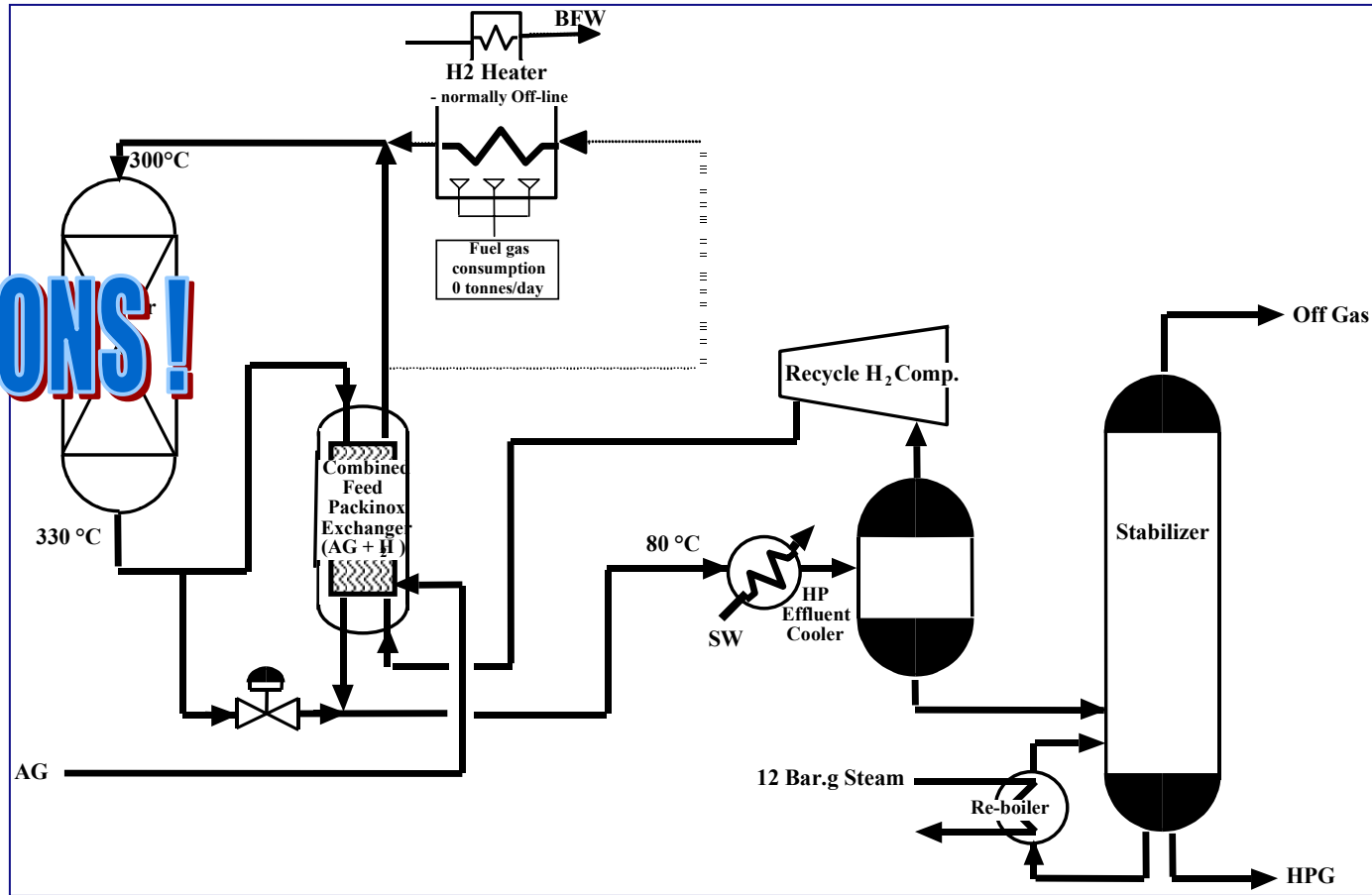
- Unit with S&T before Revamp with PSHE
 - Heater 28 MM BTU/hr
- Operation Restricted by Limits on Air Pollution



Case Story: Pygas Hydrotreater (Mitsui, Japan)

- **Eliminated:**
 - **100% of Heater Duty after Warm-Up**
- # **ZERO EMISSIONS**
- **On line since 1995**
 - **Allows to Operate during Air Emissions Restriction**

ZERO EMISSIONS!



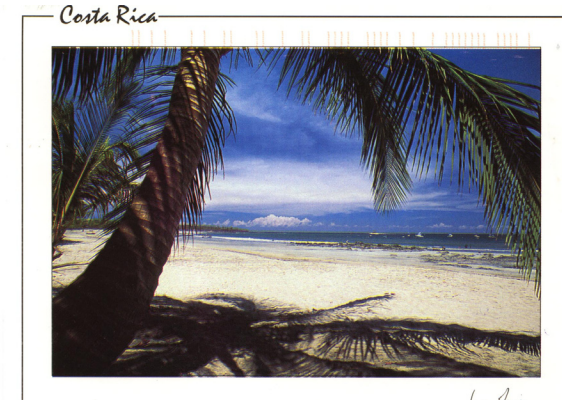
Summary

High Efficiency
Shell & Plate
Heat Exchangers

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Lets Make Them as Green As We Can!